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CONTROL OF SOD WEBWORMS IN LAWNS

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BULLETIN NO. 391

Control of Sod Webworms in Lawns

By H. H. JEWETT

Sod webworms are native to America. They were not introduced from foreign countries as were so many injurious insects. They injure two kinds of crops; corn and tobacco following sod or weedy land, and meadows, pastures, lawns, and grass land of all kinds. The injury to grasses is ordinarily inconspicuous and the actual amount of injury is practically impossible to estimate. Sod webworms are a real factor in reducing the productivity of grass land and this may be readily understood when it is known that often there are thousands of worms on an acre of sod land and each consumes several blades of grass a day. Worms are present in the field from early spring to late fall. During periods of abundant rainfall, the plants are seldom injured and the only loss is the actual amount of grass eaten. In dry seasons, especially in midsummer, the plants themselves are often severely injured and the grass on considerable areas of pasture land and lawns is killed, as was true in 1930 and 1931. Because of an apparent increase in the number of worms during the past few seasons, a study of methods for controlling them, especially in lawns, was begun in the spring of 1934.

REVIEW OF THE LITERATURE ON CONTROL METHODS

There is a considerable number of species of sod webworms, but only a few attack plants of economic importance. General control measures that apply especially to controlling injury to corn following sod are summarized by Ainslee (2). Such practices as early fall plowing followed by disking and cultivating

early in the spring to kill grass and weeds are recommended, the main object being to starve the worms. Ainslee also states that attempts to poison the worms in grassland or to poison or trap the adults have not been successful. The appearance of worms in destructive numbers in 1930 and 1931 in lawns, pastures and golf greens, attracted considerable attention, and several insecticides were recommended by investigators as means of control or partial control.

W. A. Price (1), as a result of experiments made by himself and the writer, recommended kerosene emulsion for controlling sod webworms in lawns. The stock emulsion, made of ½ pound of hard soap, 1 gallon of water, and 2 gallons of kerosene, was diluted with 27 gallons of water and applied at the rate of 1 gallon to 6 to 8 square feet of sod. W. B. Noble (3, 4) recommended two commercial pyrethrum extracts or kerosene emulsion for controlling sod webworms in golf greens. The pyrethrum extracts were to be diluted at the rate of 1 ounce to 4 gallons of water in one case and 1 ounce to 5 gallons of water in the other, and applied at the rate of 1 gallon to 1 square yard of turf. The kerosene emulsion was made of 1 pound of laundry soap, 1 gallon of water, and ½ gallon of kerosene. One gallon of the emulsion was added to 50 gallons of water and 1 gallon of the diluted emulsion was applied to 1 square yard of turf. H. F. A. North and G. A. Thompson, Jr. (5) tried several different insecticides to control sod webworms in turf, and state that lead arsenate, 2 pounds in 20 gallons of water, applied to 1,000 square feet is a very promising remedy. H. F. A. North and T. E. Odland (6) recommend a spray of 1 to 2 pounds of lead arsenate in 10 or 20 gallons of water, applied to 1,000 feet of turf. Roy E. Campbell and M. W. Stone (7) state that b,b-dichloroethyl ether, 10 cc in 1 gallon of water, applied at the rate of 1 gallon to 1 square yard of turf, killed 100 percent of the worms. These authors also state that pyrethrum extract, 1 ounce in 4 gallons of water, applied at the rate of 1 gallon of diluted extract on one square yard, brought many of the webworms to the surface but only a few were killed, and that carbon disulfide emulsion, 2½ ounces in

10 gallons of water, with soap, was only partially effective; also that kerosene emulsion, made of 1 pound of soap, 1 gallon of boiling water and ½ gallon of kerosene, diluted by adding 1 gallon of emulsion to 50 gallons of water, when used at the rate of 1 gallon of diluted emulsion to 1 square yard of turf, was not effective. J. U. Gilmore and J. Milam (8) recommend for controlling the corn root webworm, *Crambus caliginosellus* Clem. injuring tobacco, a poisoned bait made of Paris green 1 pound, corn meal 25 pounds, nitrobenzene 1 ounce. Best results were from the use of 15 to 20 pounds per acre.

SEASONAL HISTORY

Three species of sod webworms are commonly found infesting sod in the Bluegrass Region of Kentucky: the bluegrass webworm, *Crambus teterrellus* Zinchen; the striped sod webworm,

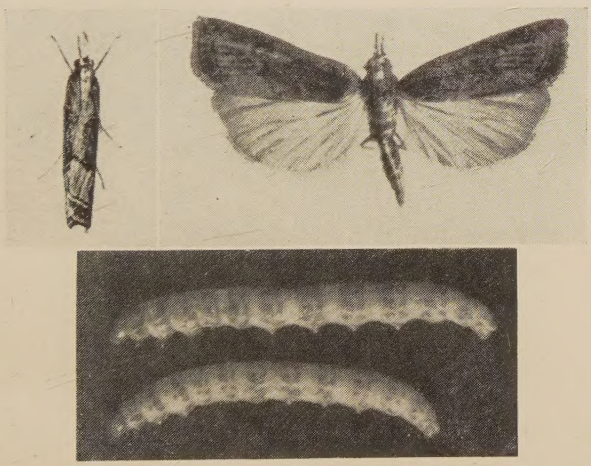

Figure 1. Crambus teterrellus and larvae. About twice natural size.

Crambus mutabilis Clemens; and the leather-colored sod webworm, *Crambus trisectus* Walker.* The bluegrass sod webworm is the dominant species. Adults were observed at lights in the field during the seasons of 1934 to 1937.

* Species determined by Dr. Carl Heinrich, Bureau of Entomology and Plant Quarantine, Washington, D. C.

The bluegrass sod webworm adult, *Cambus teterrellus,* appeared first on May 21, in 1934, and from June 1 to June 15 there was a marked increase in number followed by a decline to about July 10. A pronounced flight occurred from July 25 to August 9, decreasing in number to August 15. A small flight occurred on September 11 and a few days later. In 1935, the first adult was observed on June 5 and a fairly numerous flight occurred from June 11 to June 22. Very few adults were seen in July, but a second flight occurred from August 2 to August 19.

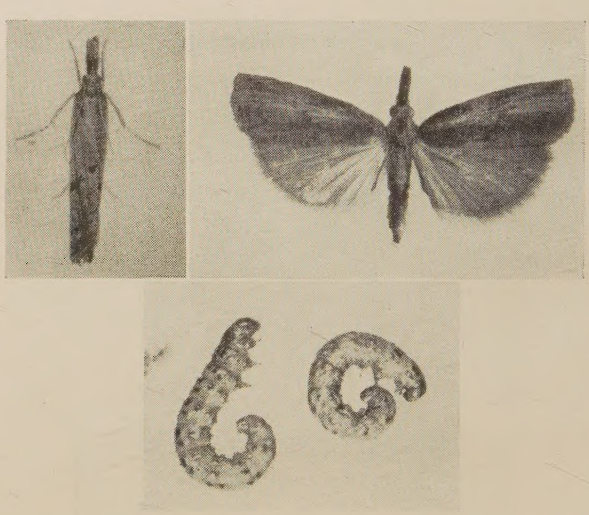

Figure 2. Crambus mutabilis and larvae. About twice natural size.

There were a few adults at lights from the later part of August to October 1, but no definite flight. In 1936, adults were first observed on June 5. The number increased to June 15 and then decreased during the rest of June. Practically no adults were seen in July, but a second flight began on August 3 and lasted for about two weeks. No other flight occurred but a few individuals were collected in September. In 1937, adults began appearing at lights on May 25, with a strong flight on June 8 to June 22. A second flight commenced on July 22 and continued to about

August 16 but from then on only a few were seen till the middle of September, when a slight increase in number was observed. From observations on the flight of this species, it seems very likely that in 1934 and 1937 there was at least a partial third brood.

Crambus mutabilis was observed first on May 11, in 1934, and there was a flight of adults during the first two weeks of June, followed by practically no adults from June 16 to July 10. A second flight occurred July 24 to August 7, after

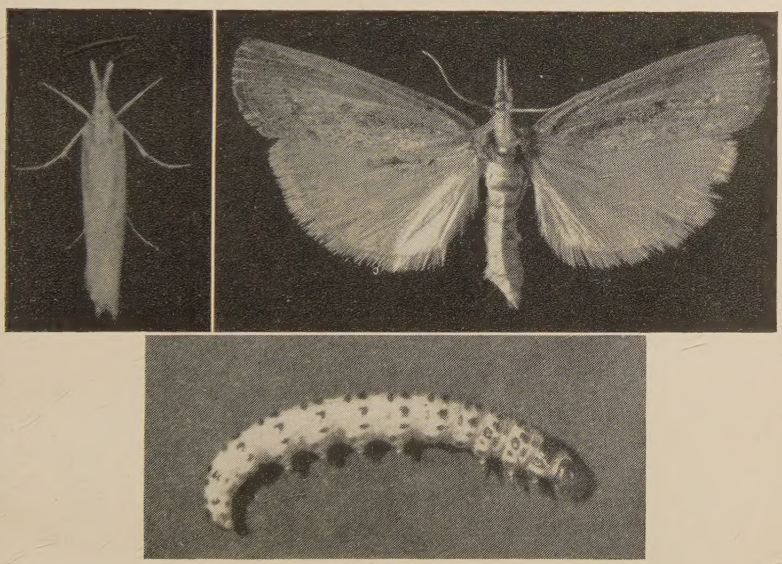

Figure 3. Crambus trisectus and larvae. About twice natural size.

which the number decreased to August 16. No other flight occurred to October 1. In 1935, adults were first observed May 31, followed by a general flight June 12 to June 25. A second flight occurred August 1 to August 20 and then a few individuals to September 13. No later flight appeared. The number of adults of this species observed at lights in 1936 was very small. A few adults appeared June 5 to June 15 and a slightly larger number on August 3 to August 24. No other

flight occurred to the first week of October. In 1937, there was a main flight of adults during the first two weeks of June and then a few individuals to July 23, when a second flight began. This flight lasted to August 11 and then there was a gradual decrease in number to August 24. A very few specimens were seen at lights from August 24 to October 1.

Crambus trisectus was first observed May 20, in 1934, and there were two main flights, the first during the first ten days of June and the second July 24 to August 9. A few adults were seen September 5, but no real flight. In 1935, a few adults were collected June 11, but for the rest of the season only an occasional adult was seen at the lights. This species was not numerous in 1936, but there was a small flight June 5 to June 15 and one from August 3 to August 11. During the season of 1937, adults of this species were much more numerous than in the preceding three seasons. Adults began collecting at lights May 26, with greatly increased numbers June 7 to June 16. From July 6 to the beginning of the second flight, July 22, very few adults were seen. The main second flight occurred July 30 to August 18. After August 24, a few adults were seen to October 1, but there was no real increase in number to indicate a third brood.

The number of broods for the three species, as indicated by flight of adults during the seasons 1934 to 1937, is normally two, with a probable partial third brood for *Crambus teterrellus* in 1934 and 1937.

CONTROL EXPERIMENTS

General Procedure. The bluegrass sod used for tests for controlling sod webworm was kept and maintained practically as a lawn would be kept. In order to have enough worms in the sod for tests, adults were collected at lights and placed in cages enclosing 20 square feet of sod. The adults dropped their eggs in the sod and, except in 1936, a considerable number of worms were found in each cage. In 1936 eggs failed to hatch in the field, probably because of excessively high temperatures at the times adults were collected. Infested sod was also found where lights were placed in the field.

All sprays were applied several days before pupation began. The stages of development of the larvae were determined by frequent examinations. The sprays were applied with a pump giving about 50 pounds pressure. All sections of sod sprayed were surrounded by board frames, either as parts of the cages

Figure 4. A tunnel made by a larva of Crambus mutabilis, 2 times natural size.

or additional ones to prevent the larvae from moving out of the treated areas.

To determine the results of the treatments, it was necessary to make a careful examination of the sod. In each case, the grass was clipped close to the soil and the surface of the soil was

examined for larvae. Then the sod was torn apart or lifted and torn apart and examined carefully. It was generally necessary to screen the materials to collect the smaller larvae. Ten square feet of sod were examined for each test.

Insecticides and Rates of Application. Kerosene emulsion made of ½ pound of hard soap, 1 gallon of water, and 2 gallons of kerosene was used at three dilutions, 1 part to 50, 1 part to 15, and 1 part to 10 of water, and was applied at the rate of 2 gallons of diluted emulsion to 20 square feet of sod. Loro, a proprietary product, 1 ounce in 4 gallons of water, was used at the rate of 2 gallons on 20 square feet of sod. Barium carbonate 10 pounds in 20 gallons of water was used at the rate of ½ gallon on 20 square feet. Nicotine oleate 1 part to 200 parts of water was used at the rate of ½ gallon on 20 square feet of sod. Lead arsenate 1, 1.6, 2 and 3 pounds in 20 gallons of water was used at the rate of ½ gallon on 20 square feet of sod. Lead arsenate powder was used at the rate of ¾ pound on 100 square feet. Pyrethrum in two different products was used, one contained 30 percent resin and 37 percent inert ingredients, and one, 2 grams of pyrethrins per 100 cc. Both were used at dilutions of 1 ounce in 4 gallons of water, applied at the rate of 2 gallons on 20 square feet. Lethane jr., a proprietary product, 1 part to 200 parts of water, was applied at the rate of ½ gallon on 20 square feet. Derris powder containing 4 percent rotenone, 2½ pounds in 50 gallons of water, was used at the rate of ½ gallon on 20 square feet of sod. B, b-dichloroethyl ether 10 cc in one gallon of water was applied at the rate of 2 gallons to 20 square feet. A bait made of 25 pounds of corn meal, 1 pound of Paris green, and 1 ounce of nitrobenzene, was used at the rates of 2½ and 5 pounds to 100 square yards.

Results. Preliminary tests of several insecticides were made and the more efficient were selected for more extensive trials. The insecticides selected were used in five tests each during the seasons of 1934, 1935, and 1937. The results are given in tables 1 and 2.

The preliminary tests were made mainly in June, in 1934

and 1935, on first-brood worms, and in September on second-brood worms, in 1937. Kerosene emulsion diluted by mixing 1 part with 50 of water, was used at the rate of 2 gallons to 20 square feet on two plots, July 3, 1934; only 6.3 and 25 percent of the worms in the sod were killed. The stock emulsion was made of ½ pound of hard soap, 1 gallon of water, and 2 gallons of kerosene. Noble (3, 4) recommended an emulsion containing only ½ gallon of kerosene. This was diluted 1 part to 50 of water and used at the rate of 1 gallon on 1 square yard of turf. Campbell and Stone (7) state that kerosene emulsion as recommended by Noble was not efficient. Kerosene emulsion diluted 1 part to 15 of water and applied to one plot July 7, 1934, killed 68.3 percent of the worms and in a second test on one plot, July 18, killed 58.2 percent.

At a dilution of 1 part to 10 of water, in one test July 9, 1934, 95.2 percent of the worms were killed and in another July 31, 1935, 94.4 percent were killed.

Loro, barium carbonate, and nicotine oleate, in single tests in July, 1934, gave practically no control. Lethane Jr., and cuprous cyanide in single tests in July, 1935, failed to give good control

Lead arsenate was used as a powder and as a spray. The powder applied on one plot on July 30, 1935, at the rate of ¾ pound on 100 square feet of sod, killed 71.9 percent of the worms. In two preliminary tests made on September 5, 1934, 1.6 pounds in 20 gallons of water killed 83.9 and 90 percent of the worms, and in another test July 30, 1935, killed 78.2 percent. Two pounds in 20 gallons of water killed 92.5 percent of the worms on one plot treated July 3, 1934, and 92.1 percent on another treated July 31, 1934. North and Thompson (5) state that 2 pounds of lead arsenate in 20 gallons of water applied to 1,000 square feet of sod is a promising control for sod webworms. North and Odland (6) recommended a spray of 1 to 2 pounds of lead arsenate in 10 to 20 gallons of water. In the above tests, where 2 pounds of lead arsenate were used in 20 gallons of water, the applications amounted to 2½ pounds on 1,000 square feet.

Three pounds in 20 gallons of water killed 94.9 percent of the worms on one plot treated September 16, 1935.

Pyrethrum spray, 1 ounce in 4 gallons of water, used in two preliminary tests on July 3, 1934, killed 98.8 and 98.3 percent of the worms. The pyrethrum spray contained 30 percent of resin and 37 percent of inert material. This same spray was used in the series tests in 1934 and 1935. The spray used in 1937 had a pyrethrin content of 2 grams in 100 cc. Noble (3, 4) recommends pyrethrum extracts as effective; North and Thompson (5) say that dilute pyrethrum extract is only moderately effective. Campbell and Stone (7) state that pyrethrum 1 ounce in 4 gallons drives the worms to the surface, but is not effective. Diluted pyrethrum extract does drive a good percent of the worms from their burrows as was repeatedly observed during a good number of treatments; however, the writer found that a very large percent of the worms died. In a single instance, on July 13, 1935, 100 worms were collected from 5 square feet of freshly treated sod. The worms were placed on untreated sod and approximately 24 hours later, 96 were dead. The treated sod was then examined and 28 dead worms and 1 live worm were found.

Dichloroethyl ether, 10 cc in 1 gallon of water, was applied to two plots on July 13, 1937, at the rate of 1 gallon on 1 square yard of sod, as recommended by Campbell and Stone (7). On one plot, 31.4 percent and on another, 53.6 percent of the worms were killed. Several other tests of this chemical were made in 1938 because of the favorable results reported from its use. Two different brands of the chemical were used and each was applied to a set of five plots. Treatments of five plots with one brand of the chemical in July resulted in the following percentages of worms killed: 62.5, 56.0, 64.7, 55.0, and 74.0. On the plot where 62.5 percent of the worms were killed, 20 cc of the chemical in one gallon of water was used and on the other plots 10 cc in one gallon of water. Treatments of five plots in September with a second brand of the chemical resulted in the following percentages of worms killed: 66.6, 42.8, 54.9, 69.0, and 50.0. The chemical was used at the rate of 20 cc in one gallon of water on

the plot where 66.6 percent of the worms were killed and 10 cc in one gallon of water on the other plots.

The poisoned bait, recommended by Gilmore and Milam (8) as partially effective against the corn root webworm affecting tobacco, was used on five plots August 30, 1937. This bait was not effective in controlling the worms in sod even at large dosages.

Series Tests. The insecticides selected for the more extensive trials are kerosene emulsion 1 part to 10 of water; lead arsenate 2 pounds in 20 gallons of water; pyrethrum extract 1 ounce in 4 gallons of water. The results of the tests are summarized in table 1.

The results from the use of these three insecticides were examined for proportional differences to determine which, if any, gave significantly better control. In 1934, the proportion of the worms killed by kerosene emulsion is 91.2 percent and by the pyrethrum spray 95.5 percent, a difference of 4.3 percent. The standard error of this difference is 1.546. The difference between the proportions is 2.8 times the standard error. This is considerable difference in favor of the pyrethrum, but not highly significant if three times the standard error is considered as highly significant. The kerosene emulsion and lead arsenate show very little difference between the proportions killed, and the difference is not significant. The pyrethrum spray gave a significantly better kill than the lead arsenate spray. The difference between the proportions is 6.1 percent, and the standard error of the difference, 1.735. The difference between the proportions is 3.5 times the standard error which is considered significant.

In 1935, there was very little difference in the proportion of worms killed by the three sprays. No difference between proportions is significant. The 1937 tests showed greater differences in the proportions of worms killed by the sprays. That year, the proportion of worms killed by the pyrethrum spray was 96.1 percent and for kerosene emulsion 93.2 percent. The difference between the proportions is 2.9 percent and the

standard error is 1.51. The difference between proportions is 1.9 times the standard error. This difference is in favor of the pyrethrum spray, but not significant. The difference between the proportions killed by kerosene emulsion and lead arsenate is 7.1 percent. The standard error of the difference is 2.024 and the difference, 7.1 percent, is 3.1 times the standard error. The proportion killed by kerosene emulsion is significantly better than that by lead arsenate. The difference between the proportions killed by the pyrethrum spray and lead arsenate is 10.0 percent. The standard error of the difference is 1.873. The difference between the proportions is 5.3 times the standard error, a significant difference in favor of the pyrethrum spray.

Kerosene emulsion, during three years' tests, killed about the same percent of the worms each year; pyrethrum was less effective in 1935 than in 1934 and 1937; and lead arsenate killed about the same proportion of the worms each year. Pyrethrum was more effective than lead arsenate in 1934 and 1937 and killed a little larger percent of the worms in 1934 and 1937 than kerosene emulsion, but the difference was not significant. Kerosene emulsion gave significantly better control over lead arsenate only in 1937.

Effect of the Insecticides on Bluegrass Sod. Kerosene emulsion (standard formula) diluted 1 part to 10 parts of water and applied at the rate of 2 gallons on 20 square feet did not cause any permanent injury to bluegrass sod. In one instance, the tips of newly clipped grass were burned slightly. Injury is likely to occur also where the grass has been injured by tramping. Free oil in the diluted emulsion burns the grass. Lead arsenate and the pyrethrum sprays did not injure bluegrass sod.

Conclusion. Three insecticides, if properly applied to bluegrass sod, give reasonably good control of sod webworms. These are pyrethrum extract, kerosene emulsion, and lead arsenate. In general, pyrethrum extract was more efficient than the other two, and lead arsenate slightly less efficient than kerosene emulsion.

SUMMARY

The sod webworms commonly found in bluegrass sod are the bluegrass sod webworm, *Crambus teterrellus;* the striped sod webworm, *Crambus mutabilis;* and the leather-colored sod webworm, *Crambus trisectus.* Observations on adults at lights indicate two broods and a partial third for *Crambus teterrellus* and two broods for the other two species.

Insecticides tried were pyrethrum, kerosene emulsion, lead arsenate, dichloroethyl ether, barium carbonate, nicotine oleate, derris, "loro", "lethane, jr.", and poison bait. A spray containing pyrethrum was the most effective for controlling the worms in bluegrass sod. A pyrethrum extract containing 2 grams of pyrethrins in 100 cc should be diluted at the rate of 1 ounce to 4 gallons of water and applied at the rate of 2 gallons to 20 square feet.

A kerosene emulsion made of ½ pound of hard soap, 1 gallon of water and 2 gallons of kerosene may be used with good results at a dilution of 1 part to 10 of water, applied at the rate of 2 gallons to 20 square feet. The emulsion must be very carefully prepared to prevent injury to the grass.

Lead arsenate 2 pounds in 20 gallons of water was fairly effective when applied at the rate of 2½ pounds to 1,000 square feet. Soap or some other material should be added to the spray to make the lead arsenate stick to the grass.

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APPENDIX

Table 2 gives the results of the spraying experiments from the individual plots from which the summary in table 1 was derived. Standard kerosene emulsion was diluted 1 part to 10 of water; pyrethrum spray, 1 ounce to 4 gallons; lead arsenate, 1 pound to 10 gallons. The kerosene emulsion and pyrethrum sprays were applied at the rate of 1 gallon to 10 square feet; the lead arsenate spray, 1 quart to 10 square feet.

TABLE 1. Percentages of sod webworms killed in bluegrass sod by treatments with insecticides. Each figure is the average of 5 tests of each insecticide. The number of worms is the total for 5 tests.

Insecticide	1934		1935		1937	
	Percent	Number of worms	Percent	Number of worms	Percent	Number of worms
Kerosene emulsion 1 part, water 10 parts; 2 gal. of diluted emulsion on 20 sq. ft. of sod	91.2	529	91.7	459	93.2	443
Pyrethrum spray 1 oz. in 4 gal. of water; 2 gal. of diluted spray on 20 sq. ft. of sod	95.5	479	90.2	434	96.1	446
Lead arsenate 2 lbs. in 20 gal. of water with ⅛ pint of liquid tar soap. ½ gal. spray on 20 sq. ft. of sod	89.4	445	91.9	465	86.1	451
Treatments made	Sept. 5		Sept. 13, 15		July 13	

TABLE 2. Results of spraying sod webworms in bluegrass sod.

Year and plot number	Kerosene emulsion		Pyrethrum spray		Lead arsenate spray		No treatment	
	Number of worms	Percent dead	Number of worms	Percent dead	Number of worms	Percent dead	Number of worms	Percent dead
1934. September 5								
1	125	96.0	75	96.0	51	92.1	86	4.8
2	90	83.3	65	92.3	100	86.0	76	0.0
3	115	89.6	101	97.0	90	91.1	78	0.0
4	95	94.7	94	97.9	64	87.5	45	0.0
5	104	92.3	144	94.4	140	90.3	51	2.0
Total	529	.....	479	.....	445	.....	336	.....
Mean	.....	91.2	.....	95.5	.....	89.4	.....	1.4
1935. September 13 to 15								
1	104	86.5	62	87.1	71	91.5	23	0.0
2	73	89.0	80	95.0	82	92.7	58	1.7
3	96	95.8	84	89.3	120	93.3	61	0.0
4	66	95.5	107	92.5	90	86.7	76	1.3
5	120	91.7	101	87.1	102	95.1	97	0.0
Total	459	.....	434	.....	465	.....	315	.....
Mean	.....	91.7	.....	90.2	.....	91.9	.....	0.6
1937. July 13								
1	69	100.0	78	96.2	98	84.7	60	1.7
2	96	95.8	82	95.1	75	80.0	49	0.0
3	84	90.5	76	96.1	85	89.4	53	0.0
4	89	91.0	94	94.7	106	90.6	74	1.4
5	105	88.6	116	98.3	87	85.6	98	0.0
Total	443	.....	446	.....	451	.....	334	.....
Mean	.....	93.2	.....	96.1	.....	86.1	.....	0.6